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Gamifying a CSCL and its effect on collaboration and self-organization

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Abstract: InterLACE (Interactive Learning and Collaboration Environment), is a Computer-Supported Collaborative Learning (CSCL) tool that was developed at Tufts University to support active learning in high school Physics education. Usability testing yielded positive results, but usability did not translate to usage in a learning environment. In classroom testing, peer-to-peer interactions among student users did not live up to expectations. Gamification, or the use of design elements characteristic for games in non-game contexts, was identified as a possible means to encourage more interaction among users. A study was conducted to examine the influence of gamification on the number of interactions and self-organization that occurs in InterLACE users during a high school Physics learning activity. University students in the Boston area (N = 48) between the ages of 18 and 31 were recruited and randomly assigned in groups of 4-6 to two conditions: gamified and control. Gamifying elements were introduced in the experimental condition, such as rules for earning points, a leaderboard, badges and time constraints. The leaderboard provided immediate feedback on individual scores and rank in relation to other players. Results indicate an increase in inter-participant collaboration indicated by a greater number of interactions (15.37 vs. 4.81 average per person). Participation also increased, as indicated by the count of words posted (303.14 vs 205.99 average per person). The number of self-organized groups formed were also higher (4 vs 1.6), but the difference between the two conditions was not statistically significant.

Keywords: Collaboration, CSCL, gamification, human factors

1. Introduction

Traditional education has given much emphasis to the interaction between students and teachers. Class discussions have been teacher-centric, with the teacher being perceived as the main source of information. Many hours have likewise been devoted to the interaction between students and materials, such as textbooks and curriculum. The interaction among students is seemingly not as well thought out (Johnson & Johnson, 1988).

According to Johnson and Johnson (1988), there are three ways in which students interact with each other in the learning process: they can compete with each other; they can work individualistically, being measured against a set of criteria; or they can work cooperatively. Having students work alone, whether individualistically or competitively, is the dominant interaction pattern in most classrooms. This goes against the majority of research on this topic, which reveals that students learn more effectively when they work cooperatively. Students achieve more and they are more positive about school, subject areas, teachers and each other. Moreover, they have more effective interpersonal skills.

Working collaboratively is a natural consequence of the innate sociability of humans (Mendoza & Galvis, 1998 as cited in Zea et al., 2009). Social interaction lets us access opinions and attitudes that are different from our own. During the learning process, interacting with others in a group modulates students' tendency to oversimplify complex concepts (Zea et al., 2009). This occurs as a result of exposure to different opinions from other students about the concept being studied.

Collaboration in learning can be supported through the use of technology. Computer-Supported Collaborative Learning (CSCL) emerged in the 1990s as a reaction to software that forced students to learn as individuals. In recent years, more and more technology for CSCL has been introduced in the classroom (Stahl, Koschmann & Suthers, 2006).

InterLACE (Interactive Learning and Collaboration Environment), is a CSCL tool that was developed at Tufts University to support high school Physics instruction ("Visual Classrooms," n.d.). It

aids students in the process of creating, interacting and refining their ideas within a common workspace. The software allows an instructor to post a question (a "prompt"), to which users can then respond. It enables the users to capture their ideas in text, graphical or video form, then just as easily share these ideas with other users on a common display. Collaboration and idea refinement is encouraged by providing tools for commenting on and tagging posts, and comparing images. The user interface for InterLACE was designed using Human Factors principles, specifically to build user collaboration.

Usability has been defined as "the degree to which something is easy to use and a good fit for the people who use it". ("What is Usability?," n.d.). Usability testing was performed on the InterLACE interface and it yielded positive results. However, this usability did not translate to usage. In subsequent studies done in various classrooms, peer-to-peer interactions were examined qualitatively and were found to be less collaborative than expected (E. Danahy, personal communication, January 11, 2016). Despite being given the necessary tools for collaboration, students still needed the motivation to use them.

Motivation can be described as the general desire of someone to do something. For students, the motivation to learn is important because they need to be receptive to the topic being taught. There are a number of ways that teachers may help to motivate students to interact and collaborate with their peers (Tharp, 1987). They can provide ways for students to demonstrate mastery of the topic. Moreover, instructors must provide early and continual feedback regarding student performance. Lastly, providing multiple paths for students to excel can make more of them believe that they can do well in the course.

Gamification is defined as *the use* (rather than the extension) of *design* (rather than game-based technology or other game-related practices) *elements* (rather than full-fledged games) *characteristic for games* (rather than play or playfulness) *in non-game contexts* (regardless of specific usage intentions, contexts, or media of implementation) (Deterding, et al., 2011). It can be used to motivate students by addressing several of the means for motivation mentioned above. It employs tasks for students to be able to solve problems and demonstrate their mastery of a particular topic (Lee & Hammer, 2011). Gamification affords students the chance to interact with game elements and other students - something they cannot obtain from a textbook. These interactions give students the chance to earn points and advance in the game. Scores provide timely and continual feedback (Lee & Hammer, 2011). Finally, games can provide multiple opportunities to obtain scores, thereby providing multiple paths for students to excel (Nicholson, 2015).

Gamification has been a trending topic for the past few years as a means to increase user activity, social interaction and quality and productivity of actions (Hamari, Koivisto, & Sarsa, 2014). In a recent review of twenty-four peer-reviewed, empirical studies on gamification, nine were in the field of education or learning. All nine reported positive outcomes when gamification was used, such as increased motivation, engagement and enjoyment in the learning tasks (Hamari, et al., 2014). This supports our intention to use gamification as a means to increase motivation in a learning context.

This study examines the gamification of the InterLACE environment and its influence on the level of collaboration and self-organization that occurs in a group of student users. It attempts to answer the following research questions:

1. Does gamification of InterLACE influence the level of collaboration among users?
2. Does gamification of InterLACE lead to increased participation among users?
3. Does gamification of InterLACE influence self-organization among users?

The level of collaboration among users of InterLACE may be measured by the number of comments and tags that a user made on another user's posts, as well as the number of ideas that a user obtains from another user and incorporates into their revised answer, referred to as "uptake". Only comments that show engagement with the subject matter should be counted. Others that merely express an emotion or reaction should be excluded from the count. A user's level of participation may be measured by the number of words they posted during the session. Lastly, self-organization into groups may be measured as the number of two or more users mutually commenting on each other's posts.

The level of collaboration is measured because we aim to increase user interaction on InterLACE. User participation is measured because it indicates the extent of user motivation to engage in the activity. We are also interested in measuring self-organization because it indicates that users are engaging in a discussion. This back-and-forth of ideas provides opportunities for deeper understanding of the topic being discussed.

2. Literature Review

2.1 What Motivates Play

The basis for the game design was a study on motivations for online play. Multi-User Dungeons or MUDs are multi-player real-time virtual worlds. In order to answer the question "What motivates people to play?", experienced MUD players were asked "What do people want out of a MUD?" Bartle (2004) summarized the answers and identified 4 archetypal player types:

- *Achievers* - like doing things in the virtual world to achieve defined goals. They play in order to earn points and rank high.
- *Socializers* - like interacting with other players in the virtual world, either as themselves or as their characters.
- *Explorers* - enjoy discovering new things about the virtual world and how it works.
- *Killers* - play in order to dominate others. This takes the form of attacks or covert mechanisms such as sowing intrigue, rumor-mongering or making others feel guilty.

Graphing these 4 player types on a two-dimensional graph gives Figure 1:

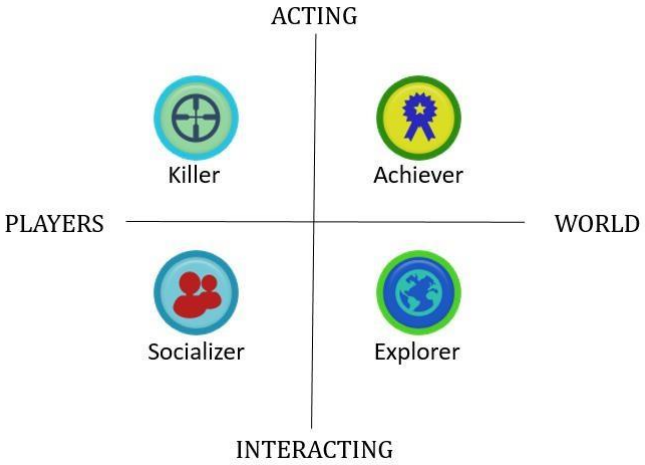

Figure 1. Player interest graph. Figure and accompanying text adapted from (Bartle, 2004)

The graph describes the player types in terms of two characteristics: how much they prefer acting on things versus interacting with them, and how much they prefer to do that on the players or on the virtual world. *Achievers* derive fun from acting on the virtual world. *Explorers* derive fun from interacting with the virtual world. *Socializers* derive fun from interacting with other players. *Killers* derive fun from acting on other players.

Providing various types of game elements can harness the different ways in which people are motivated to play. For example, *Achievers* are motivated by scores and rank information, so using a leaderboard would motivate them to participate in the game. *Killers* are motivated by the chance to dominate fellow players, so the game must include a mechanism for players to act on each other.

2.2 Gamification of Learning Environments

Gamification of a learning environment must be implemented with an understanding of how it encourages student motivation. Applied well, gamification allows experimentation with rules, emotions and social roles. A well-designed game has rules that allow players room to explore and master the tasks. Specific, moderately difficult, immediate goals serve to motivate learners (Locke, 1991 as cited in Lee & Hammer, 2011).

Gamification offers students a chance to see failure as an opportunity to learn something, and for rewarding effort and not just mastery. Games encourage experimentation and failing by employing rapid feedback cycles and low stakes. School, on the other hand, has high stakes and very long feedback

cycles. Students have few opportunities to fail without consequence (Pope, 2003 as cited in Lee & Hammer, 2011).

2.3 Self-Organized Groups in Learning Environments

Previous research concerning groups in a learning environment suggests that the method of study group formation relates to student performance.

In an undergraduate introductory accounting course, individuals performed better in self-organized study groups than in groups formed by assignment or students who chose not to join a group (Swanson, Gross & Kramer, 1998). Furthermore, allowing self-organized groups to form may increase the effectiveness of collaborative learning for higher-performing students (van der Laan Smith & Spindle, 2007).

In another study, researchers found that group formation was likely not influenced by knowledge of other students' prior performance as much as previously formed friendships or by coincidence (Selanne & Kurhila, n.d.). However, the enhanced social awareness brought about by making the grades transparent could have had an implicit effect on group formation. For example, the students may have expected a certain level of performance from other students given the knowledge of the latter's previous scores.

3. Method

A total of ten trials were conducted using two conditions: five trials each for *gamified* and *control*. Table 1 compares the two conditions in terms of materials used and procedure. Each trial lasted approximately two hours. Five to six participants were recruited for each trial, but due to no-shows, the number of participants per trial ranged from 4-6 people.

In order to remove the element of bias, the researcher stayed in a different room throughout the trials, and communicated all instructions via chat (Google hangouts). This, along with the 2-hour time constraint, prevented face-to-face training for InterLACE and the Leaderboard. Instead, the participants were trained via videos demonstrating the use of these applications. This had the additional benefit of ensuring that participants across trials received the same kind of training.

Table 1: The two conditions.

Condition and Materials	**General Procedure**
Control N = 24 InterLACE Training InterLACE	1. Using InterLACE, a cluster of 4-5 participants were asked to answer a prompt individually using any online resource. 2. They were then given a chance to revise their answer and to use other features of InterLACE in the bonus round. 3. Their answers to the prompt were scored. Their revised answers and any collaborative action taken in the bonus round were also scored. 4. The participants were not informed of their scores. 5. The process continued until all five prompts were answered.
Gamified condition N = 24 InterLACE Training Leaderboard Training Leaderboard Quick Ref Guide InterLACE Leaderboard	1. Using InterLACE, a cluster of 4-6 participants were asked to answer a prompt individually using any online resource. 2. They were then given a chance to revise their answer and to use other features of InterLACE in the bonus round. 3. Their answers to the prompt were scored. Their revised answers and any collaborative action taken in the bonus round were also scored. 4. They were shown their scores and rank using a leaderboard. 5. The process continued until all five prompts were answered.

3.1 Participants

Forty-eight volunteers were recruited from graduate and undergraduate classes (36 females, 12 males, ages 18-31) and randomly assigned to the two conditions. Participants were told that their participation in this research would improve collaboration in InterLACE. They were compensated with $20 Amazon gift cards, and participation credit in an Engineering Psychology class according to class policy.

3.2 Game and Badge Design

Different gamifying elements were used in order to appeal to the various ways that the archetypal player types are motivated to play the game. The use of a leaderboard motivates the *Achiever* types who are interested in scores and rank information. Commenting on other players' posts provides *Socializers* with the means to reach out to other players. Providing an opportunity to use other players' ideas allows *Explorers* to know the game in a deeper way. The ability to tag other players' posts provides *Killer* types the opportunity to act on other players.

These elements allow the various player types to act within the game. *Achievers* drive the effort to give correct answers because they value high scores and rank. *Socializers* drive the interactions because they question and appreciate other posts. *Explorers* interact with the game by using other ideas as "uptake". *Killers* would tag high-performing *Achievers* positively while they would tag low performers negatively.

Autonomy was fostered in the players by giving them the freedom to set goals regarding how to engage with the game. Players could select their goals based on the type of activities that interested them, or the type of player they identified with the most. Badges could then serve as indicators of players' progress toward their goals. Symbols of the archetypal player types were a logical choice for the design of the badges that were used for the game. The *Killer* player type was replaced with *Evaluator* since the former evoked negative responses from participants during pilot testing.

3.3 Experiment Design

Participants did the same core task, but the *gamified* group was given immediate feedback of their performance and rank through the use of a leaderboard. Figure 2 illustrates the general procedure and the differences between the c*ontrol* and g*amified* conditions. The participants' scores were revealed to them (by using a leaderboard) before the bonus round of the next prompt. In doing so, they would be able to see the scores for the previous prompt, and *Achiever* types could determine which player to model their actions on during the bonus round.

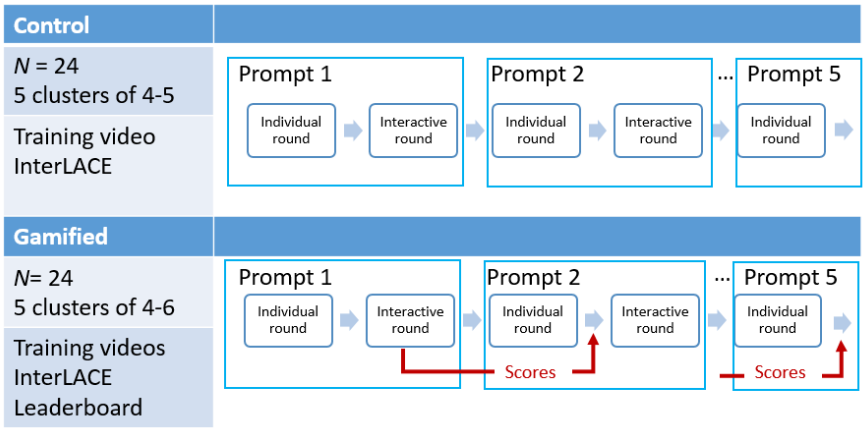

Figure 2. Summary of procedures for both conditions

3.4 Materials

There were three kinds of materials that were used for the experiment. The first one was video material used for training, the second one was the printout of the Quick Reference Guide for the Leaderboard, and the third was the Leaderboard itself. Three videos were produced for the study: 1) An introduction

to the study and an explanation of the consent form, 2) A training video demonstrating the use and features of InterLACE, and 3) A training video for interpreting the Leaderboard. The training videos included a short quiz at the end, in order to assess the participant's understanding.

Participants in the *gamified* condition were provided with a printout of the quick reference guide for the Leaderboard. It was intended to be used during the session as a reminder of how to interpret each part of the Leaderboard.

The design for the user interface of the leaderboard is shown in Fig. 3 below. The leaderboard shows player scores on the left side, and player rankings on the right. On the top left of the page are a name selector, the player name, their total points and overall rank. It also shows the badges they have earned. The center of the page shows the name of the session, and the upper right portion shows the date that the session occurred.

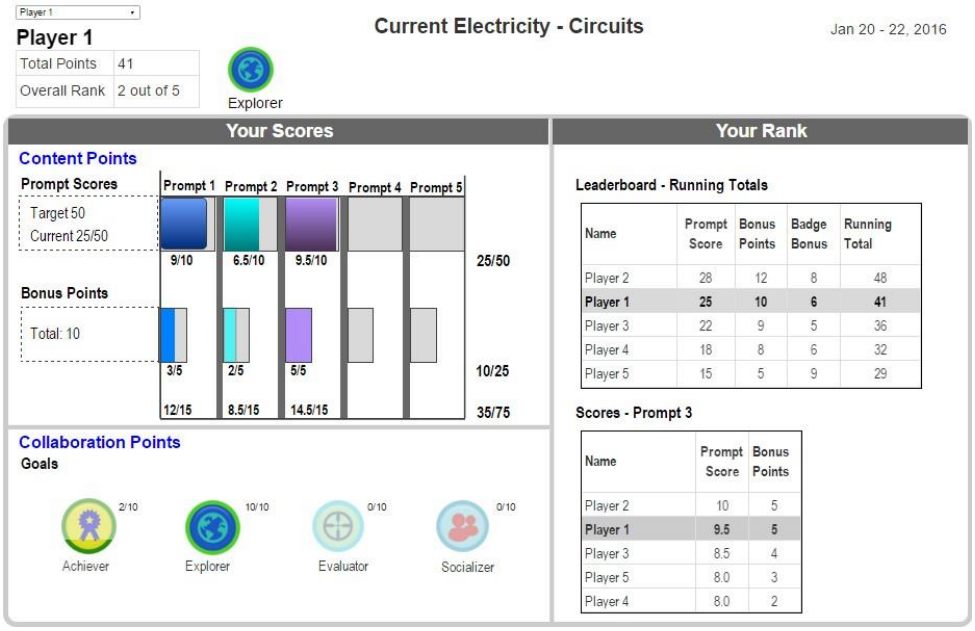

Figure 3. Leaderboard interface

3.5 Procedure

One condition (either *control* or *gamified*) was tested for a particular session. Participants were seated in individual cubicles, given a Chromebook, and assigned anonymous Participant IDs. Participants in the *gamified* condition were provided a printout of the Leaderboard Quick Reference Guide.

1. The participants watched an introductory video to explain the study and the consent form.
2. The participants then watched a training video that explained the actions available on InterLACE that they would be using for the study. They joined a live session on InterLACE and tried out the individual actions on the test session.
3. The participants in the *gamified* condition watched the Leaderboard training video and were referred to the Quick Reference Guide that was provided to them earlier.
4. Participants performed the following tasks during the experiment:
    a. Answered the first prompt using any online resource. They could only see other players' answers once they posted an idea. (8 minutes)
    b. Revised their answer based on other players' posts and used InterLACE features. This was the Bonus round. (4 minutes)
    c. Answered some survey questions on an online questionnaire. While they were doing this task, the researcher evaluated their scores. In the *gamified* condition, the researcher updated the Leaderboard before the Bonus round of the next prompt. (5 minutes)
    d. Moved to the next prompt and repeated the process until all prompts were answered.

4. Results

The Results section focuses on data obtained from Prompt 2 onwards. Recalling the procedure of the experiment (Figure 2), the participants' scores were revealed to them via the Leaderboard before the bonus round of the next prompt. Therefore, the influence of gamification would have only started in Prompt 2. There was no feedback from the Leaderboard in Prompt 1. Hence, it was decided to omit results for Prompt 1 from the calculations.

4.1 Collaboration

The level of collaboration among the players in a trial was measured by the number of interactions: the total of comments and tags made on another user's post, as well as uptake. Table 2 shows the results for the interactions averaged over the four prompts and all sessions.

Results of an independent samples t-test showed that interactions among participants in the c*ontrol* trials (*M* =4.81, *SE* = 0.97) were lower than that among participants in the g*amified* trials (*M* = 15.37, *SE* = 2.09). This difference, -10.56, 95% CI [-15.87, -5.25], was statistically significant *t*(8) = -4.58, *p* = .002.

Figure 4 shows the cumulative interactions over the 4 prompts, averaged per person. While the interactions in the *control* condition show a very slow rate of increase, those for the *gamified* condition shows a consistent rate of increase. This indicates that participants in the *gamified* condition were interacting at a relatively steady rate, while those in the *control* condition were not interacting much as the prompts progressed.

Table 2 Results of Average Interactions for Both Conditions

Condition	N	Mean	Standard Deviation
Control	5	4.81	2.16
Gamified	5	15.37	4.67

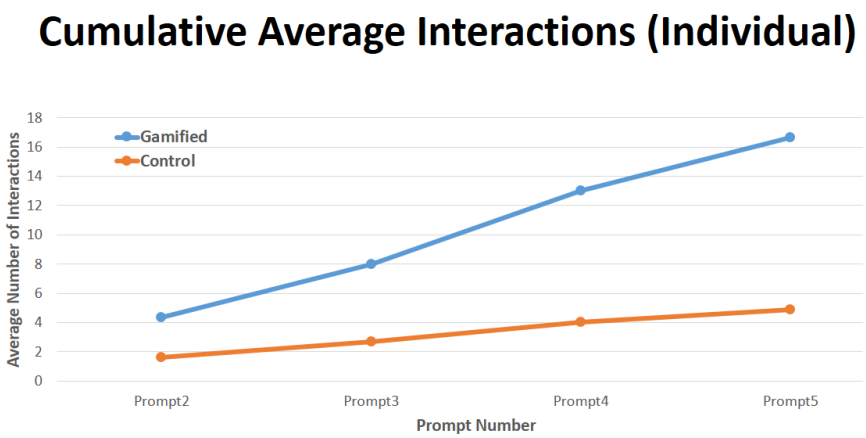

Figure 4. Interactions among players in the *gamified* and *control* conditions, averaged and cumulative per prompt

4.2 Participation

The level of participation among the players was measured by the number of words that they wrote during the session. The quantity indicates the effort they put into the activity. More words written means greater participation. Table 3 shows the results averaged over the four prompts and for all sessions.

Results of an independent samples t-test showed that the number of words posted by participants in the *control* trials (*M* =205.99, *SE* = 29.39) was lower than the number of words posted by participants in the *gamified* trials (*M* = 303.14, *SE* = 24.31). This difference, -97.15, 95% CI [-185.09, -9.20], was significant *t*(8) = -2.55, *p* = .034.

Figure 5 illustrates the average number of words that were written by players in both conditions, per prompt. It appears that the graphs start from Prompt 2 in parallel trajectories, with the *gamified*

participants posting more words. From Prompt 3, they start to diverge, ending at Prompt 5 with a larger difference than when they started at Prompt 2. These results indicate that on average, participants in the *gamified* condition were writing more at each prompt as a result of the gamified environment than those in the *control* condition.

Table 3 Results of Average Word Count for Both Conditions

Condition	N	Mean	Standard Deviation
Control	5	205.99	65.71
Gamified	5	303.14	54.36

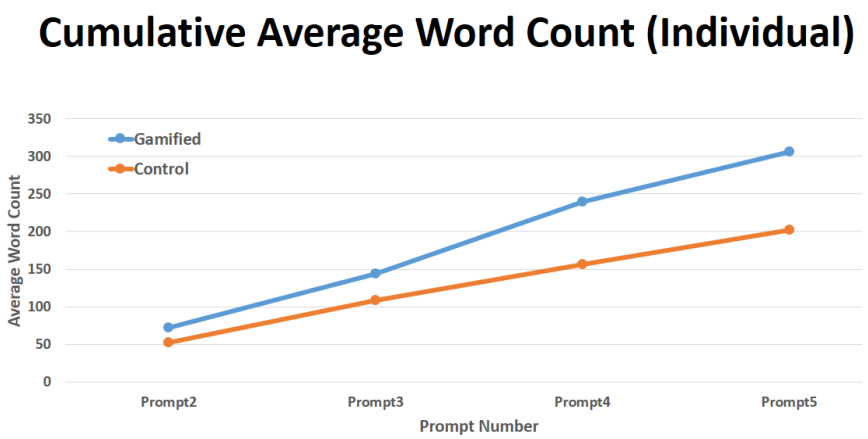

Figure 5. Individual word count in the *gamified* and *control* conditions, averaged and cumulative per prompt

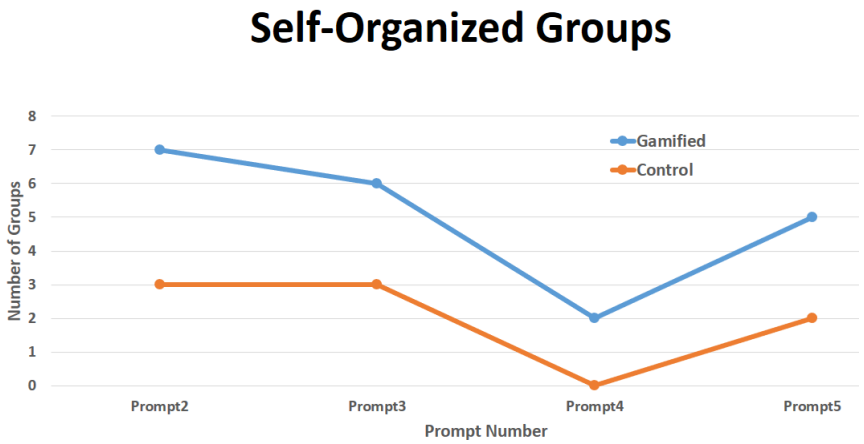

Figure 6. Plot of self-organized groups for *gamified* and *control* conditions

4.3 Self-Organization

Self-organization among users was measured by counting the number of groups of two or more people that mutually commented on each other's posts. Table 4 provides the results for both conditions. Results of the independent samples t-test showed that participants in the control trials (M = 1.6, SE = 0.51) formed less groups than the participants in the gamified trials (M = 4.0, SE = 1.14). This difference, -2.40, 95% CI [-5.28, 0.48], was not statistically significant $t(8)$ = -1.922, p = .091. However, the p value may be considered as approaching significance.

Figure 6 is a plot that compares the self-organized groups for both conditions over the course of four prompts. The graphs for both conditions appear to have the same shape, with the *gamified* condition values higher than those for the *control* condition. Despite the absence of a statistically

significant difference in self-organized groups between the two conditions, on average there were still more self-organized groups in the *gamified* condition than the *control* condition at all prompts.

Table 4 Results of Self-Organized Groups for Both Conditions

Condition	N	Mean	Standard Deviation
Control	5	1.60	1.14
Gamified	5	4.00	2.55

5. Discussion

The values obtained from the study appear to be consistent with the initial positive results obtained from usability studies on InterLACE. The participants in the *control* condition appear engaged at the start of the learning activity. This is reflected by the non-zero values of interactions among them, the words they wrote, and the groups that formed. Past Prompt 3, though, the participants in the *control* condition failed to sustain this engagement. Eventually, the number of interactions among them, the words they wrote and the groups formed failed to reach the level they were at previously for Prompt 2.

The nature of the prompts may account for some of the results. A particular prompt may have had inherent qualities that did not foster a lot of opportunity for discussion. Prompt 2 required a numerical calculation, while Prompts 3 and 4 required written explanations. The answers to Prompt 4, though, were more readily available online. That explains why participants continued to interact using tags, one-way comments and uptake on Prompt 4 than Prompt 3, but engaged in less two-way commenting, and thus less groups were formed. Regardless, the participants in the *gamified* condition consistently interacted more, wrote more words and self-organized into more groups than the participants in the *control* condition. We can infer that this difference was due to the effect of gamification in the form of feedback through the use of a leaderboard. Moreover, we can surmise that among participants in a group, this method was effective in increasing collaboration and participation, and to a lesser extent, self-organization.

Participants' opinions were obtained in a post-test questionnaire regarding the game elements' effect on their participation. Almost half of all participants said that they did not consider their fellow players' scores when they played (11 out of 24 participants). Some of those respondents professed to have less knowledge of the subject matter and were not expecting to win anyway. Those who answered "yes" mentioned that they were high scorers in the game and knowledge of other players' scores encouraged them to perform better. This suggests that seeing group scores was not universally favored. Players who were familiar with the subject matter favored seeing group scores, while those who were unfamiliar with the subject matter did not. Five out of the 11 participants who did not consider fellow player scores also said that knowing their own scores did not make a difference in their participation. Again, some of them were unfamiliar with the material and did not expect to score high. As for badges, 15 out of 24 participants said that they were helpful in setting goals during the game and that it was encouraging to earn the badges.

5.1 Significance

The results of this study may serve as a starting point for implementing ways to increase engagement not only in InterLACE but also for other CSCL tools that may have similar features. The study used three types of feedback (scores, ranks and badges), which required resources to design and develop. Qualitative results indicate that knowledge of rank and score seemed to affect participants differently based on their knowledge of the subject matter. These concerns echo parent and educator concerns with the increase in competition and stress that stems from gamification of a learning environment. As such, these types of feedback may not be the best tools to ensure better performance from everyone in the class regardless of their knowledge level previous to the learning activity. Badges provided participants with means to set goals for participation and collaboration, and provided immediate feedback as well. With limited resources, badges could be implemented relatively easier than a fully featured leaderboard.

5.2 Limitations

The study was conducted over a two-hour period and with a limited number of participants. It would be helpful to compare the results with a study done in an actual classroom learning Physics over a prolonged period of time. The participants in the study were also likely to be less invested than actual students, since there was no direct consequence on their grades however they participated in the game.

6. Conclusion

Participants in the *gamified* trials received three types of immediate feedback using the Leaderboard: scores, rank and badges. They exhibited greater collaboration, participation, and to a lesser extent, self-organization compared to the participants in the *control* trials, who did not receive any feedback. This increase in interactions may then be explained as the participants' responses to the feedback. They responded individualistically to score feedback, competitively to rank feedback and collaboratively to badges. Based on participants' qualitative responses, the use of badges had no negative effect on the participants. With limited resources, badges may be used in pilot testing the gamification of a CSCL tool.

By using gamification, the usefulness of InterLACE's features was effectively demonstrated to participants, resulting in increased engagement with each other and with the tool. Effective product design should therefore consider not only usability; it should include an assessment of the product's usefulness in achieving user goals. That is, the motivation behind its use.

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References

Bartle, R. A. (2004). *Designing virtual worlds*. New Riders.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15). ACM.

Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). Does gamification work?--a literature review of empirical studies on gamification. In *System Sciences (HICSS), 2014 47th Hawaii International Conference on* (pp. 3025-3034). IEEE.

Johnson, Roger, T., & Johnson, D. W. (1988). Cooperative Learning: two heads learn better than one. *Context*, 18.

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother?. *Academic exchange quarterly*, *15*(2), 146.

Nicholson, S. (2015). A recipe for meaningful gamification. In *Gamification in education and business* (pp. 1-20). Springer International Publishing.

Selänne, L., & Kurhila, J. Group Dynamics in Socially Aware E-Learning.

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. Cambridge handbook of the learning sciences, 2006, 409-426.

Swanson, Z. L., Gross, N. J., & Kramer, T. (1998). Alternative modes of study group formation and student examination performance. *The Accounting Educators' Journal*, *10*(2).

Tharp, A. L. (1987, February). Let's motivate. In *ACM SIGCSE Bulletin* (Vol. 19, No. 1, pp. 415-422). ACM.

van der Laan Smith, J., & Spindle, R. M. (2007). The impact of group formation in a cooperative learning environment. *Journal of Accounting Education*, *25*(4), 153-167.

Visual Classrooms (n.d.). Retrieved from https://visualclassrooms.com/about/story

What is Usability?. (n.d.). In *Usability Body of Knowledge.* Retrieved from http://www.usabilitybok.org/what-is-usability

Zea, N. P., Sánchez, J. L. G., Gutiérrez, F. L., Cabrera, M. J., & Paderewski, P. (2009). Design of educational multiplayer videogames: A vision from collaborative learning. *Advances in Engineering Software*, *40*(12), 1251-1260.